Claims

[c1] 1. A method of acquiring free-breathing MR images comprising the steps of:
monitoring heart rate of a subject just prior to image acquisition to acquire a time period of an R-R interval;
recording the time period from the heart rate monitoring to prospectively estimate future R-R intervals; and
acquiring n sets of MR data, a first MR data acquisition commencing at any point in an R-R interval and extending for the time period recorded.

[c2] 2. The method of claim 1 further comprising the steps of segmenting each MR data acquisition into n segments and repetitively acquiring each segment in n successive heartbeats.

[c3] 3. The method of claim 2 further comprising the step of combining the n MR data sets to form a set of MR images with high temporal resolution covering the R-R interval.

[c4] 4. The method of claim 1 further comprising the step of discontinuing heart rate monitoring before acquiring MR image data.

[c5] 5. The method of claim 1 wherein a second set of MR data is acquired immediately after the acquisition of the first set of MR data.

[c6] 6. The method of claim 2 wherein n=1 for fluoroscopy imaging.

[c7] 7. The method of claim 1 wherein the step of acquiring MR data is performed using one of a fast gradient-recalled echo pulse sequence and a steady state free precession pulse sequence.

[c8] 8. The method of claim 1 further comprising the steps of:
subjecting a patient to successively increased, graded levels of cardiac stress during the monitoring step until the heart rate is stabilized at a required stress level; and
acquiring MR data according to the acquisition step of several long and short axis views of at least a portion of a heart muscle to monitor cardiac function

during any portion of a stress test.

[c9] 9. The method of claim 8 wherein the cardiac stress is induced either by physical stress or administration of a pharmaceutical.

[c10] 10. A computer program for use with an MRI scanner having a computer, the computer program having a set of instruction that, when executed, cause the computer to:
receive a time-period signal indicative of an R-R interval representing a cardiac cycle of a patient;
acquire a first set of partial MR image data during a first acquisition period equal to the R-R interval;
acquire a second set of partial MR image data during a second acquisition period equal to the R-R interval; and
reconstruct an MR image by combining the first set of partial MR image data with the second set of partial MR image data.

[c11] 11. The computer program of claim 10 having further instructions to acquire n sets of partial MR image data, each frame of data in a partial MR data set being acquired at a similar time of a corresponding frame of data in each partial MR data set during the R-R interval.

[c12] 12. The computer program of claim 10 wherein the acquisition of MR data is not gated to an ECG trigger.

[c13] 13. The computer program of claim 10 wherein the acquisition of each set of partial MR data is acquired at a time irrespective of either one of an R-R interval start and end.

[c14] 14. The computer program of claim 10 wherein each portion of MR data is a segment of an MR data set.

[c15] 15. The computer program of claim 10 wherein one-half of k-space image data for a given segment is acquired during each R-R time period.

[c16] 16. The computer program of claim 10 wherein even and odd numbered

lines of a k-space matrix are acquired in successive R-R intervals.

[c17] 17. The computer program of claim 10 having further instructions to monitor heart rate and generate an R-R time period indicative of a current R-R interval in a patient while the MR scanner is idle.

[c18] 18. The computer program of claim 10 having further instructions to periodically monitor heart rate and generate an R-R time period before and after each acquisition of MR data and not during any acquisition of MR data.

[c19] 19. An MRI apparatus to acquire high-temporal resolution images comprising:
a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and
a computer programmed to:
monitor heart rate of a patient;
acquire a time period of an R-R interval of the heart rate;
store the time period of the R-R interval;
enable the MRI system and begin an MR scan of the patient at an arbitrary time in the R-R interval;
continue to acquire MR data for a time comparable to the time period stored; and
reconstruct an MR image with the MR data acquired over at least one R-R interval as estimated by the time period stored.

[c20] 20. The MRI apparatus of claim 19 wherein the computer is further programmed to:
segment data acquisition such that a portion of data is acquired during each acquisition; and
combine the segmented data acquired to reconstruct the MR image.

[c21] 21. The MRI apparatus of claim 19 wherein the computer is further programmed to acquire n sets of MR data, each having m frames, where each frame is segmented into n segments and the m frames fit within one R-R interval.

[c22] 22. The MRI apparatus of claim 19 wherein the computer is further programmed to apply one of a fast gradient-recalled echo pulse sequence and a steady state free precession pulse sequence.

[c23] 23. The MRI apparatus of claim 19 wherein the computer is further programmed to acquire one-half of k-space image data for a given segment during each R-R time period.

[c24] 24. The MRI apparatus of claim 19 wherein the computer is further programmed to acquire even and odd numbered lines of a k-space matrix in successive R-R intervals.

[c25] 25. An examination method comprising the steps of:
subjecting a patient to successively increasing levels of cardiac stress;
monitoring heart rate;
once the heart rate is stabilized at a desired stress level, recording a time period of an R-R interval;
acquiring non-gated MR data using the time period recorded to estimate R-R intervals.

[c26] 26. The examination method of claim 25 wherein the cardiac stress is induced by one of either physical exercise or administration of a pharmaceutical.

[c27] 27. The examination method of claim 25 wherein the step of acquiring MR data includes acquiring segments of each frame of data over successive R-R intervals.

[c28] 28. The examination method of claim 25 further comprising the step of combining the segments for each frame to reconstruct an image with high-

temporal resolution without requiring patient breath-holding.

[c29] 29. The examination method of claim 25 where a fraction of total k-space is acquired during each cardiac R-R interval.

[c30] 30. The examination method of claim 29 where the step of acquiring MR data includes acquiring segments of each frame of data over successive n R-R intervals in order to complete data acquisition for a CINE data set.

[c31] 31. The examination method of claim 30 further comprising repeating the acquisition to provide an updated CINE data set every n R-R intervals.

[c32] 32. The examination method of claim 31 further comprising displaying continuous cardiac wall motion activity in order for an operator to monitor cardiac wall motion in real-time.